

Correlation of Chlorophyll and Sea Surface Temperature in Sub Arctic Regions

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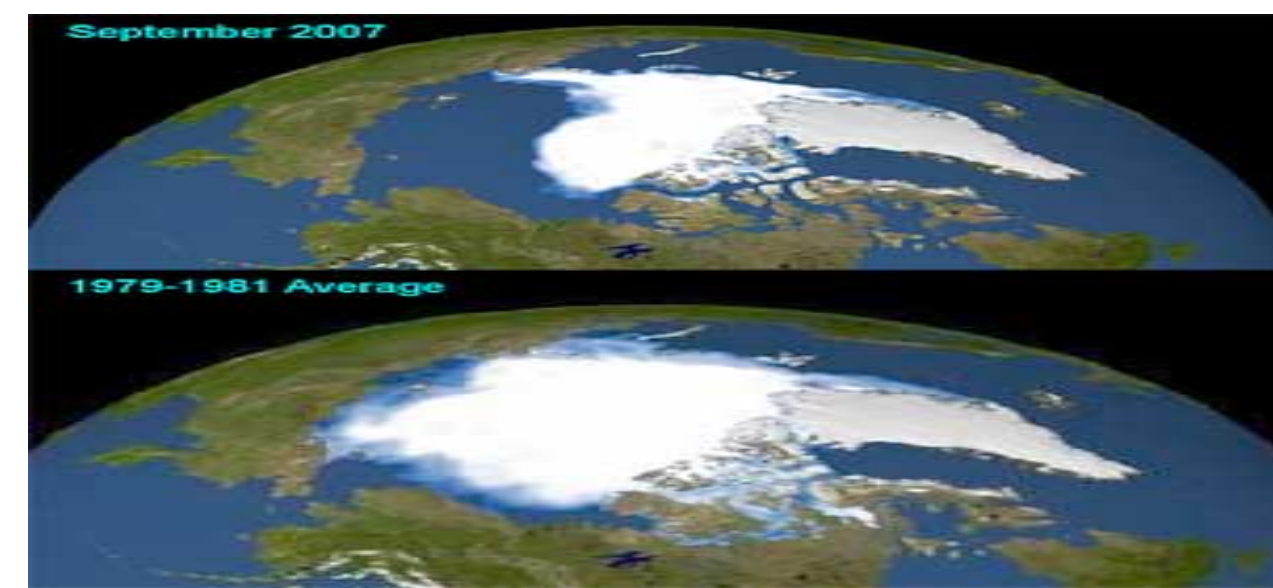
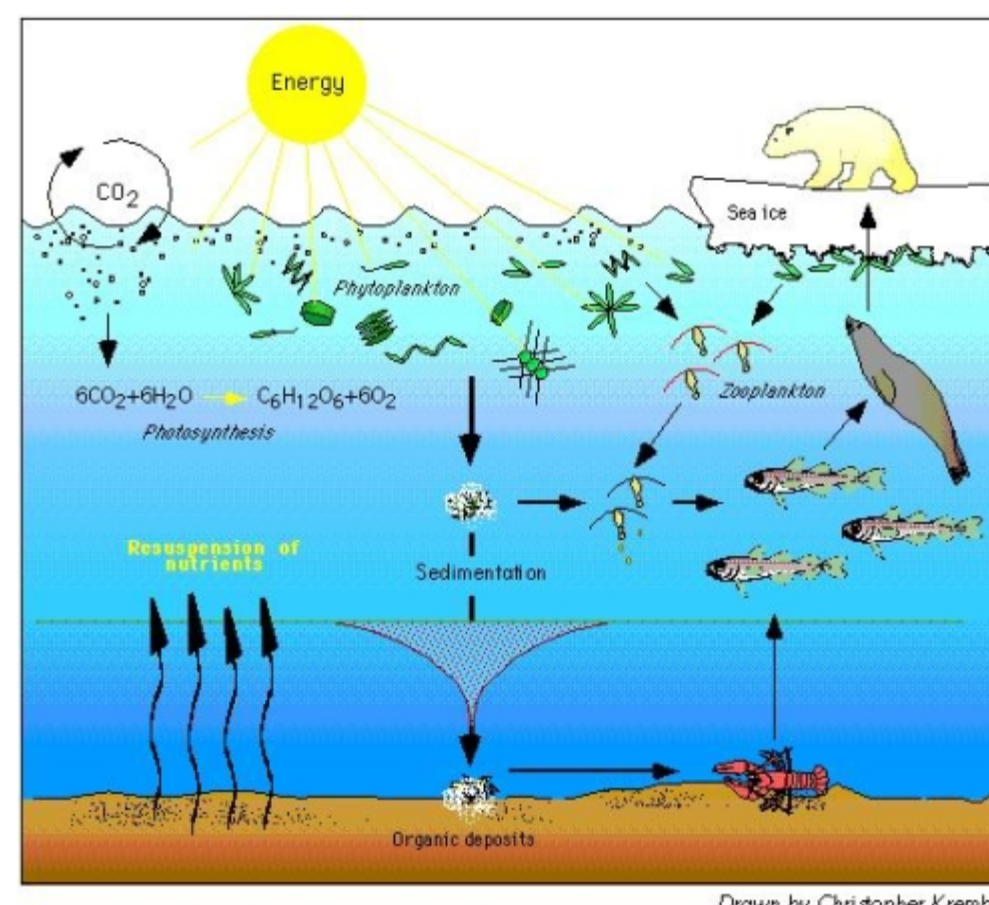
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Why Study the Arctic and Plankton in the Arctic?

The poles of the earth are more sensitive to any change in the planet's climate. In the face of ongoing climate change, the poles are warming faster than lower latitudes. It was previously thought that amplified polar warming was caused by melting ice and lowering surface albedo. Currently research shows that the seasonality of the polar warming is largely a result of energy in the atmosphere that is being transported to the poles through large weather systems. (Nasa.gov 2013 What's causing the poles to warm faster than any place on earth?)

The area of the Bering Sea where the shallow continental shelf drops off into the North Aleutians Basin is known as the "Greenbelt" because of its high amount of primary productivity. The nutrient rich water upwells from the cold waters of the Aleutian basin and mixes with the shallow waters of the shelf resulting in this high productivity (chlorophyll). In addition to the physiographic characteristics of the area, the extent, thickness, and timing of thaw of the sea ice significantly influences productivity. The ice is a significant source of IPOM (Ice derived particulate organic matter), it provides a surface for algal species to attach and grow and, at melt, inputs a significant amount of freshwater to the area.



Changes in climate will alter this pattern of productivity, if these changes occur at the time of higher predation (feeding from primary productivity) it can affect the whole ecosystem.

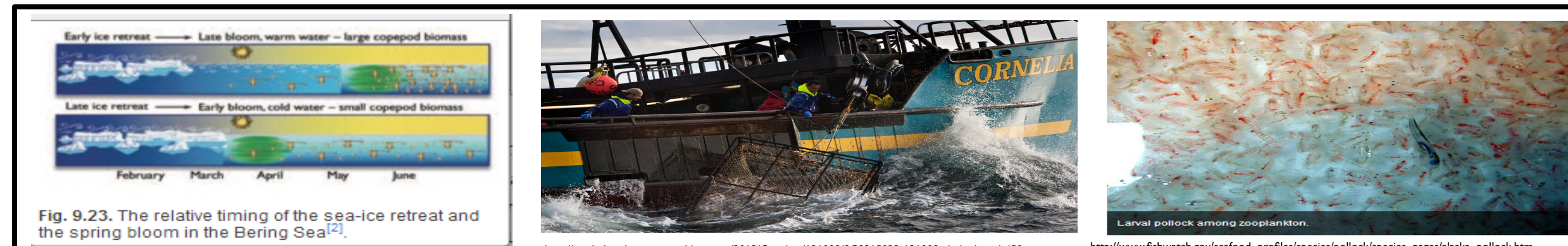
Background & Analysis

Phytoplankton biomass in the arctic varies temporally and spatially. Sea Surface Temperature (SST), as measured by MODIS, and Chlorophyll, as measured by SeaWiFS, suggest a relationship but one that is not strong enough (or there are too many other variables) to make trends easily visualized. Ice cover prevents the quantification of chlorophyll by SeaWiFS.

Overall productivity seems to be driven by a combination of factors. Temperature and timing of ice melt, upwelling (nutrients), solar radiation, ice, wind and temperature are the ingredients for primary production. Primary productivity will remain high as long as there is no nutrient shortfall. Secondary production is dependent on timing of primary bloom and ice. The extent and timing of the variables can result in significant differences in biomass of plankton and resulting energy flow throughout the ecosystem (Siger and Harvey, 2014).

Phytoplankton blooms in the Bering Sea occur in two different ways: they can start due to ice melt (early bloom), or they can happen later in the season as sunlight increases, even if the ice has melted early (late bloom). The ideal situation is for the bloom to happen when the ice is melting and there is enough sunlight for the phytoplankton to perform photosynthesis. This is not always the case, however, especially due to the changes to the sea ice that have taken place since 1976. If there is an early phytoplankton bloom in cold melt-water, when there are not as many zooplankton, most of the energy from the primary production is wasted. Late blooms happen in warmer water when there is more sunlight, and there are zooplankton present.

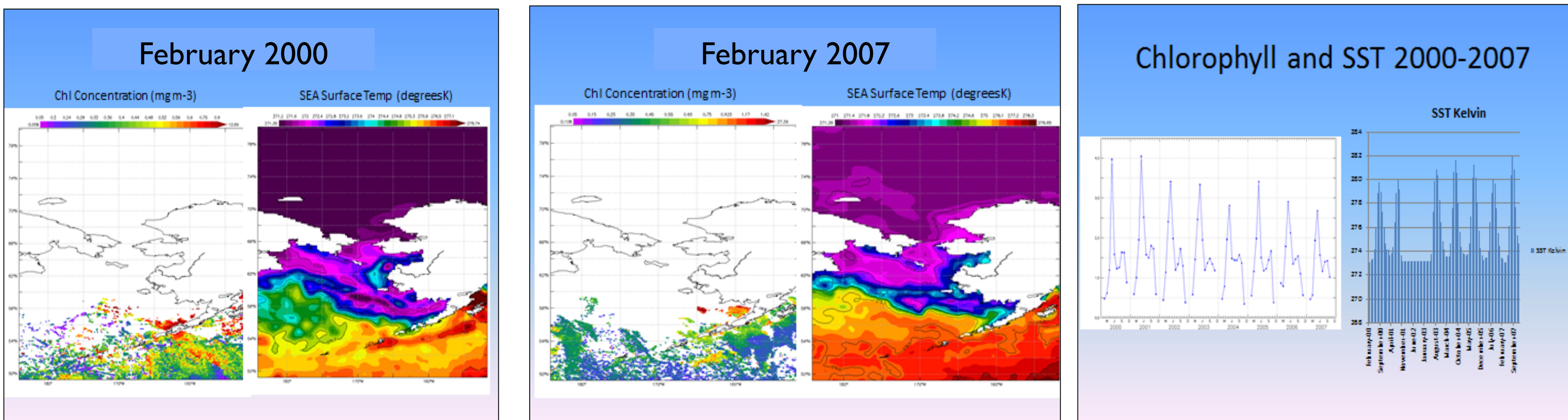
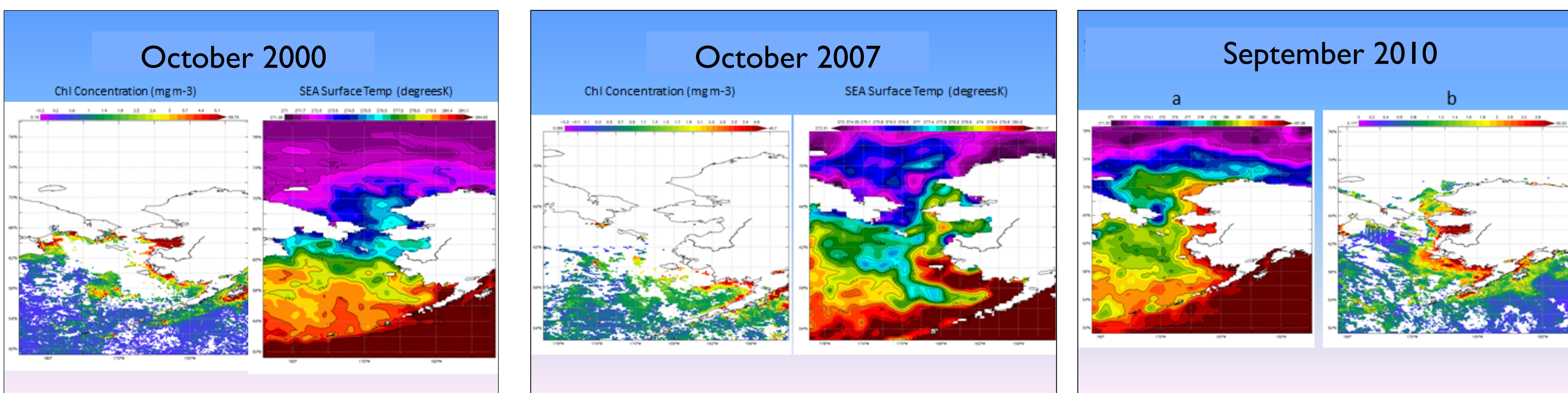
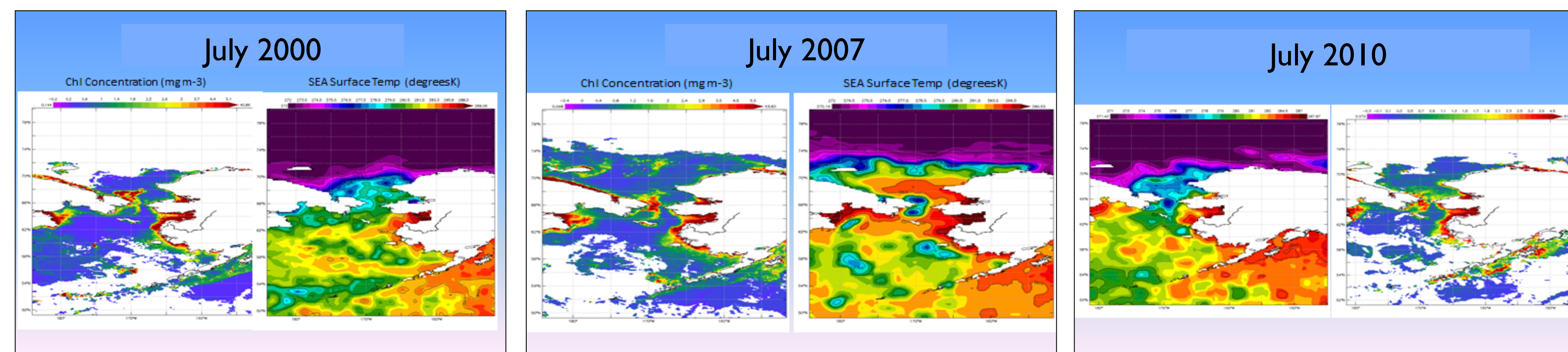
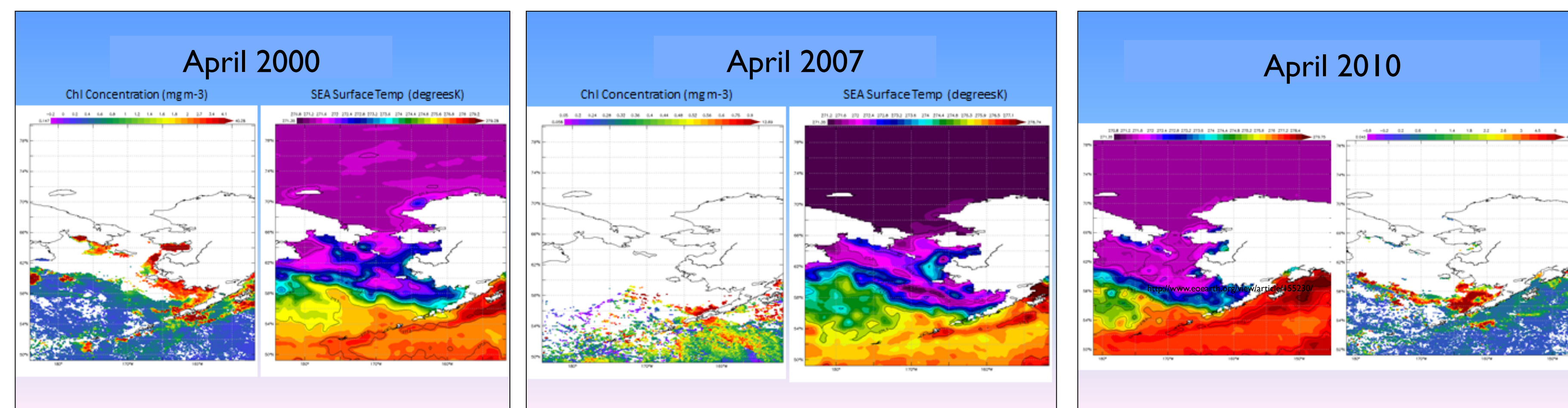
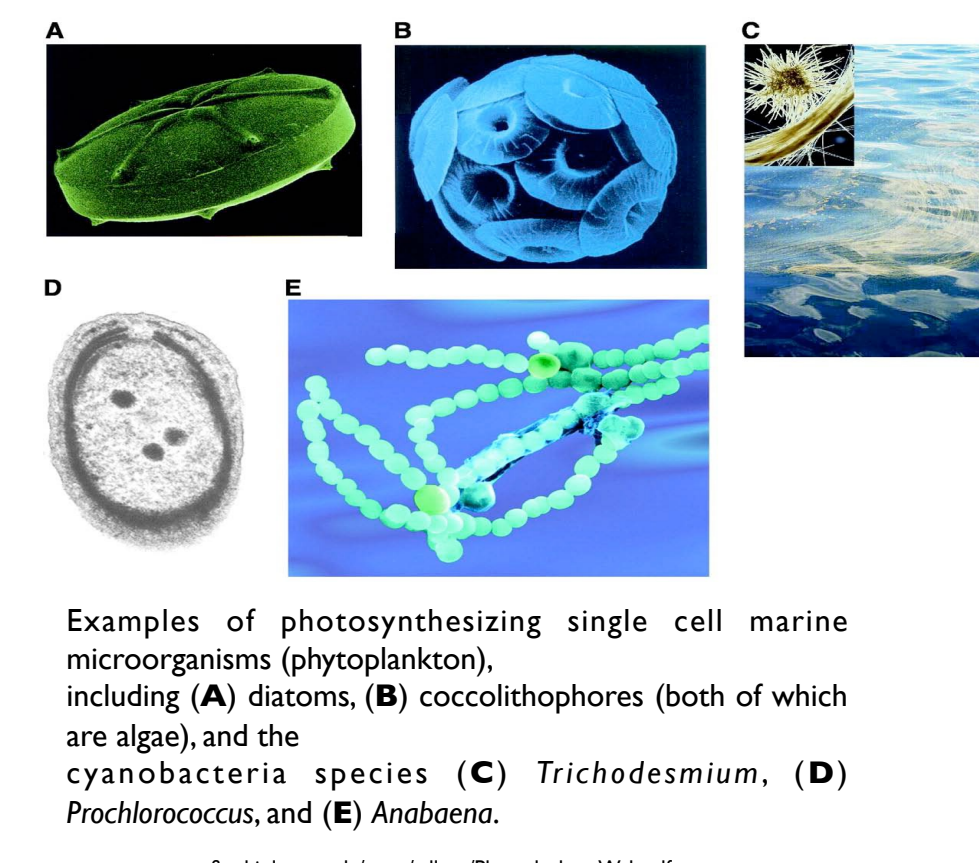
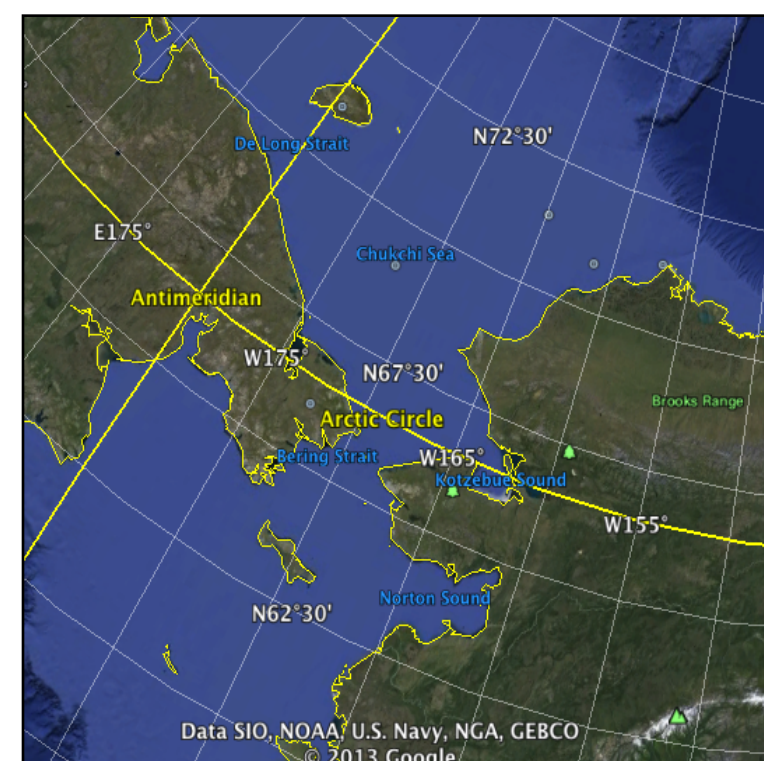
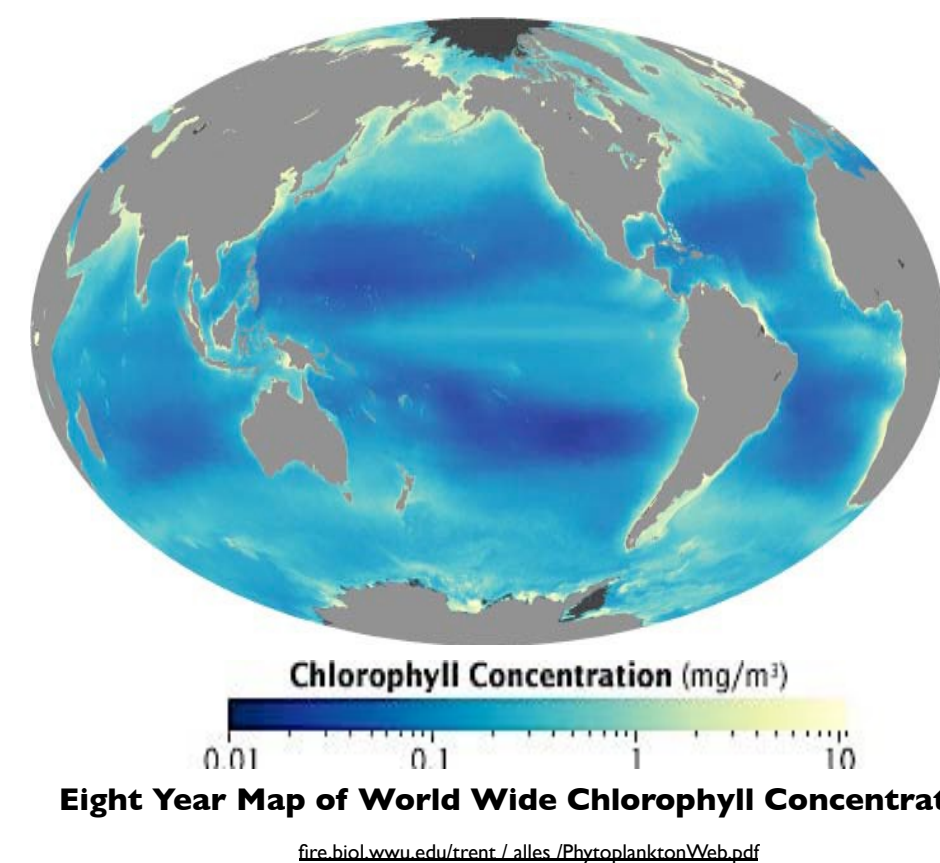
Evidence suggests that during colder years more of the primary production occurs under the ice (undetected by satellite). This ice makes it easier for zooplankton to feed on (less surface area) and large zooplankton are more numerous during these years. Also there is higher fat content in the zooplankton and therefore better for young fishes. Pollack are healthier and more numerous during cold years (Siger and Harvey, 2014). Delayed warming or on time warming is more likely to coincide with migration and spawning patterns.



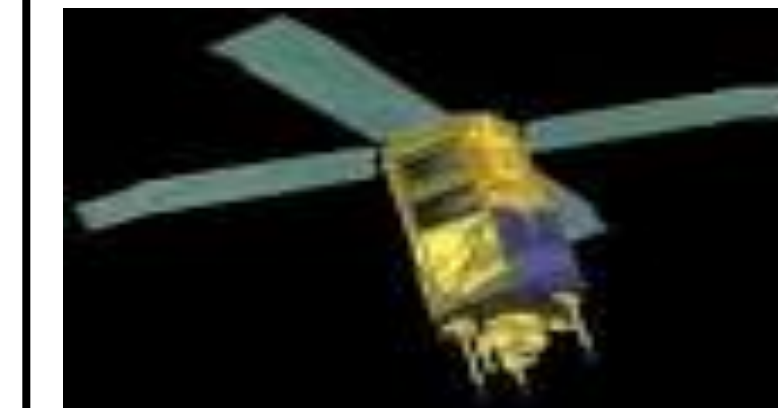
Commercial fisheries from the Bering Sea are worth about 1 billion dollars annually in the U.S. and more than half that in the Russian fishery. Major species include the walleye Pollack and other ground fish, king and opilio crabs, and salmon. Because recruitment of these fisheries is dependent on the zooplankton any climate changes will be of great importance.

The Arctic Circle

The study area for chlorophyll and sea surface temperature was 76.22N to 55.54N and 171.43W to 171.53W



Phytoplankton blooms over Arctic Ocean continental shelves were thought to be restricted to waters free of sea ice. However, field research has documented massive phytoplankton bloom beneath fully consolidated pack ice far from the ice edge where light transmission has increased in recent decades because of thinning ice cover and proliferation of melt ponds. Evidence suggests that under-ice phytoplankton blooms may be more widespread over nutrient-rich Arctic continental shelves and that satellite-based estimates of annual primary production in these waters may be underestimated by up to 10-fold (Arigon and Kijken, 2011).



Satellite Usage

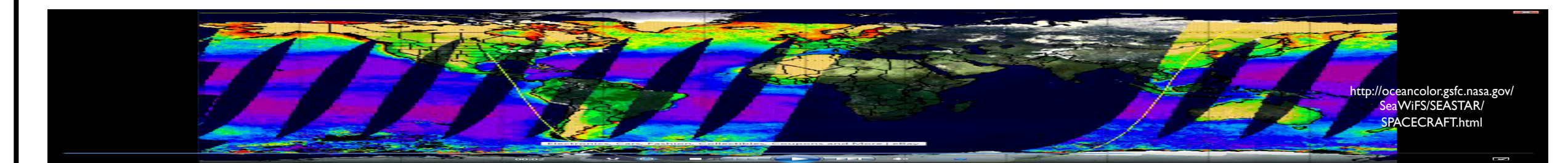


Using SeaWiFS (Sea-Viewing Wide Field of View Sensor) and Sea Surface Temperature

The SeaStar spacecraft, carries the SeaWiFS instrument and was launched to low Earth orbit onboard an extended Pegasus launch vehicle on August 1, 1997.

The purpose of the SeaWiFS Project is to provide quantitative data on global ocean bio-optical properties to the Earth science community. Slight changes in ocean color represent various types and quantities of marine phytoplankton (microscopic marine plants), the knowledge of which has both scientific and practical applications.

The sensor is designed to observe subtle changes in ocean color; and to derive from these measurements various biological and ecological indicators (such as the chlorophyll concentration distribution in the ocean). Path of the SeaWiFS satellite is shown below.



The sea surface temperature maps are based on observations by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite. The satellite measures the temperature of the top millimeter of the ocean surface. In this map, the coolest temperatures appear in blue (approximately -2 degrees Celsius), and the warmest temperatures appear in pink-yellow (45 degrees Celsius).

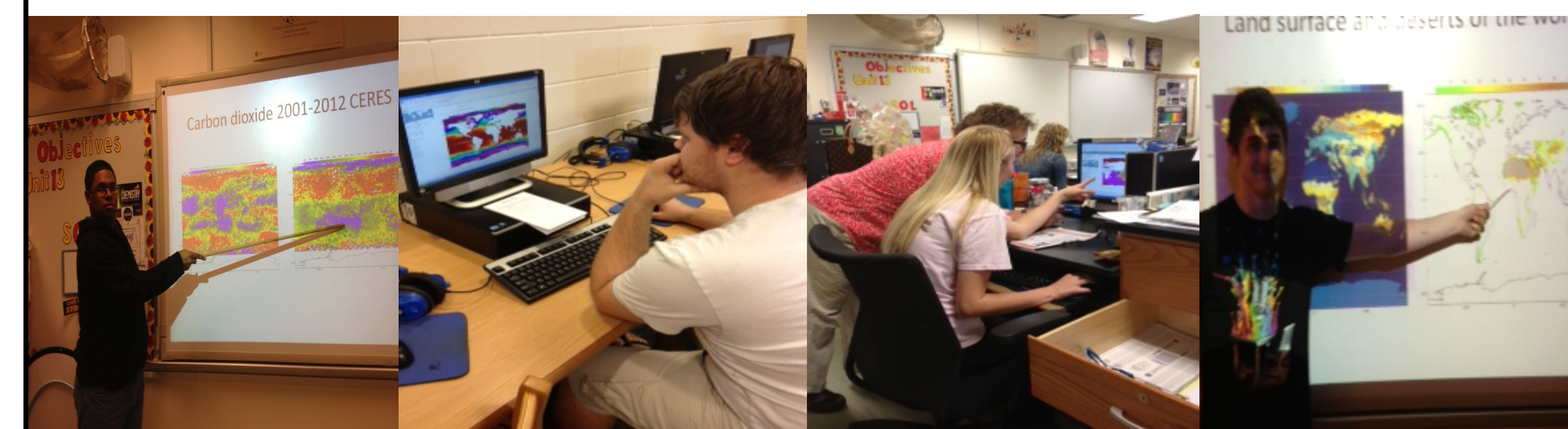
NKHS Student Involvement and Future Plans

The Ecology students at New Kent High School began a quest using MY NASA DATA (MND) to look at SeaWiFS temperature and chlorophyll data as well as other MND satellite data. Students also accessed two lesson plans from MND. The first lesson plan had students examine snow and ice changes to see how snow and ice cover have changed on the Earth from 1994 to 2004, and to practice using some of the data analysis tools available from MND. The second lesson plan was to examine the relationship between atmospheric carbon dioxide levels and chlorophyll-a measurements in a local watershed.

At the high school level it is important to look at data, to process this data, and to connect through data with scientists around the world. Not only does this give an appreciation for science but it helps students see that researchers come together to arrive at possible theories. Additionally, students learn that science confronts opinion with facts.

In future years, New Kent High School Ecology will be moving to project-based learning where students will choose a long-term project using MND. Project-based learning is a comprehensive approach to classroom teaching and learning that is designed to engage students in investigation of authentic problems. Examples of possible projects include using MODIS to explore SST in order to predict whether SST meets criteria for inducing coral bleaching and using TOPEX-POSEIDON to explore historical and current ENSO events (South Equatorial Current).

Students Working with MY NASA DATA



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